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METALS
TESTING METHODS FOR IMPACT BENDING AT LOW,
ROOM
AND HIGH TEMPERATURE

GOST 9454-78

[CT CЭB 472-77,CT CЭB 473-77]

Translated by:
M/s SWYAZ
2/453, Viram Khand, Gomti Nagar
Lucknow – 226010
☎: 0522-3098139 / 2345145
Visit us:
<http://www.swyaz.com>

S T A T E S T A N D A R D O F U S S R

METALS
Testing methods for impact bending
at low, room and high temperature

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OKCTY 1909

Effective period from 01.01.79

This standard pertains to ferrous and non-ferrous metals and alloys and stipulates testing method on impact bending at temperature from minus 100 to plus 1200 °C.

Method is based on the destruction of sample with concentrator at the center by single impact of pendulum hammer. End of sample are placed on supports. As a result of testing, the entire work, spent during impact (impact operation), or impact strength is determined.

During impact strength, it is understood that the impact operation, referred to the initial cross sectional area of sample at the place of concentrator.

(Amended edition, amendment No. 1, 2).

1. METHOD OF SAMPLING

1.1 Shape and dimensions of samples for testing should correspond to those given in table and on drawing 1-3.

Reprinted with amendment

Dimensions in mm

Type of concentrator	Radius of concentrator R	Type of sample	Length L (Maximum deviation ± 0.6)	Width B	Height, H (Maximum deviation ± 0.1)	Depth of cut, h_1 (Maximum deviation ± 0.1)	Depth of concentrator, h (Maximum deviation ± 0.6)	Height of working section H_1
U	$1 \pm 0,07^*$	1	55	$10 \pm 0,10$	10	—	—	$8 \pm 0,1$
		2		$7,5 \pm 0,10$				
		3		$5 \pm 0,05$				
		4		$2 \pm 0,05$	8			$6 \pm 0,1$
		5		$10 \pm 0,10$				
		6		$7,5 \pm 0,10$				
		7		$5 \pm 0,05$	10			$7 \pm 0,1$
		8		$10 \pm 0,10$				
		9		$7,5 \pm 0,10$				
		10		$5 \pm 0,05$				
V	$0,25 \pm 0,025$	11	55	$10 \pm 0,10$	10	—	—	$8 \pm 0,05^*$
		12		$7,5 \pm 0,10$				
		13		$5 \pm 0,05$	8			$6 \pm 0,05$
		14		$2 \pm 0,05$				
T	Cracks	15	55	$10 \pm 0,10$	11	1,5	3,0	—
		16		$7,5 \pm 0,10$				
		17		$5 \pm 0,05$	9			
		18		$2 \pm 0,05$				
		19		$10 \pm 0,10$				

* It is permitted to manufacture samples with maximum deviation ± 0.10 mm, while carrying out bulk testing.

It is permitted to use samples without cuts and with single or double unmachined surfaces, whose dimensions along the width differ from those given in table.

Area of use of samples is given in reference annexure 1.

Testing of samples of types 4, 14, 18 is carried out as per the requirement of the customer for items of special purpose.

1.2. Place of blanking for manufacturing of samples, orientation of axis of concentrator, technology of blanking and manufacturing of samples – as per GOST 7565-74 for ferrous metals, if they are not given in other normative technical documents on product

For non-ferrous metals and alloys, all this should be indicated in normative technical documents on product

Sample with concentrator of type U

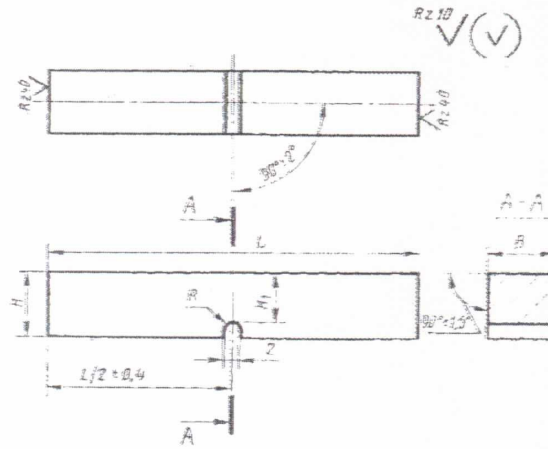


Fig. 1

Sample with concentrator of type V

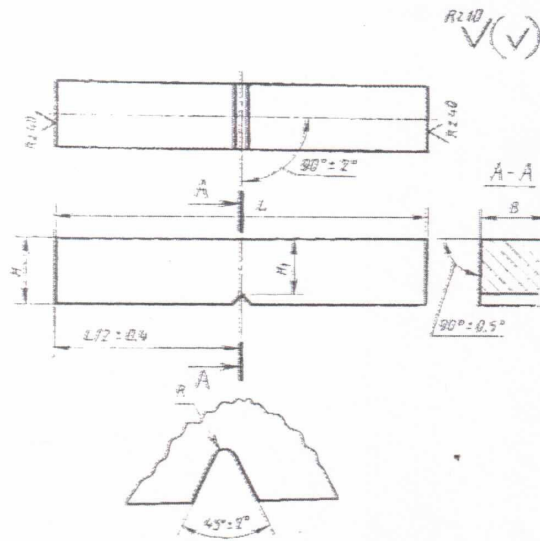
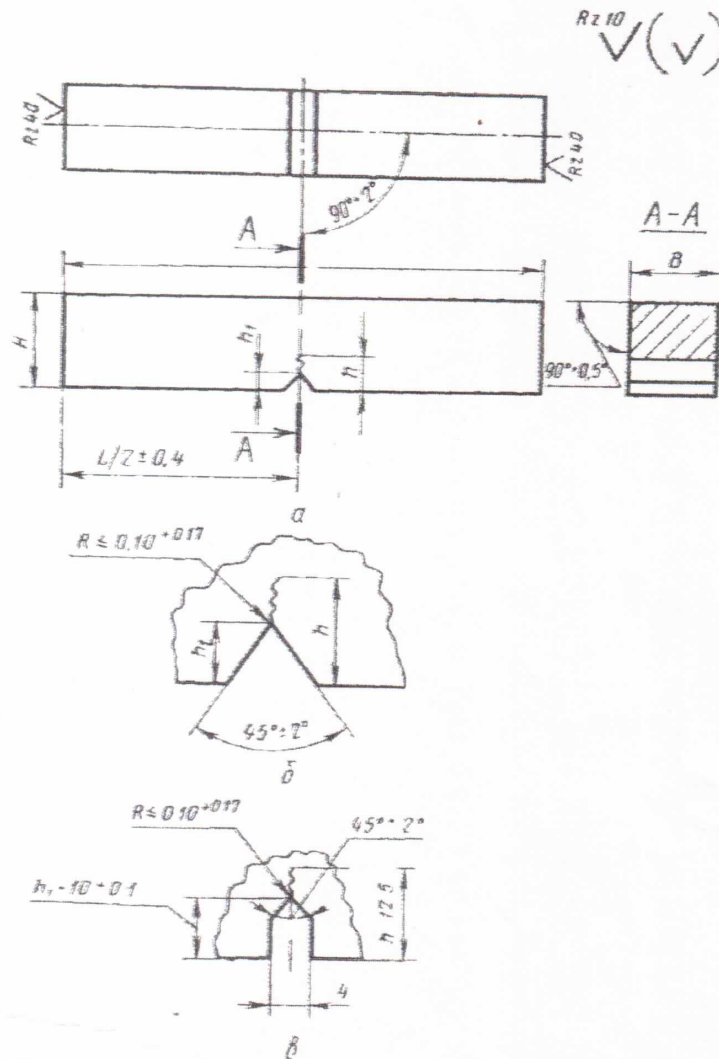


Fig. 2

Sample with concentrator of type T (Fatigue crack)



a-general view; б-shape of concentrator for samples from types 15 to 19; б- shape of concentrator for samples of type 20.

Fig. 3

While blanking of metals, samples should be protected from work hardening and heating, which changes the properties of metals, if not given in other normative technical documents on product.

1.1; 1.2 (Amended edition, amendment No. 2)

1.3. Notches on the surface of concentrator of types U and V, visible without using magnifying devices, are not permitted.

1.4. Concentrators of type T are obtained in vertex of initial cut with the flat cylindrical bend of sample. Initial concentrator can be obtained by any method.

Number of cycles, necessary for obtaining cracks of the given depth, should be not less than 3000.

1.5. Maximum residual bend, which formed, while putting concentrator of type T on samples, should not exceed: 0.25 mm – for samples having length 55 mm.

Inspection of bending of samples is carried out with the help of watch type indicator as per GOST 577-68 or by other means, which ensures the measurement error of bending not more than 0.05 mm on base length of sample.

1.6. Type and number of samples, sequence of carrying out the repeated testing should be given in the normative technical documents on exact product, certified in the established manner.

If in normative technical documents on metal product, the type of sample is not indicated, then it is suggested to test samples of type 1- upto 01.01.91

1.4-1.6 (Amended Edition, amendment No. 1, 2)

2. DEVICES AND MATERIALS

2.1. Pendulum hammer– as per GOST 10708-82. Rate of movement of pendulum at the moment of impact should be:

(5 ± 0.5) m/sec. – for hammer with normal potential energy of pendulum 50 (5.0); 150 (15); 300 (30.0) Joules (kgf•m);

(4 ± 0.25) m/sec. - for hammer with normal potential energy of pendulum 25 (2.5); 15 (1.5); 7.5 (0.75) Joules (kgf•m);

(3 ± 0.25) m/sec. - for hammer with normal potential energy of pendulum 5.0 (0.5) Joules (kgf•m) and less.

It is permitted to use hammer with other nominal potential energy of pendulum. In this case, the nominal value of potential energy of pendulum should be in such a way that, the value of impact operation is not less than 10% from the nominal value of potential energy of pendulum. Till 01.01.91, it is permitted to use hammer with those nominal potential energy of pendulum, so that impact operation is not less than 5% from the nominal potential energy of pendulum. The nominal value of potential energy of pendulum should be indicated in normative technical documents on exact product.

Basic dimensions of supports and blades of pendulum should correspond to those given on Fig. 4. For hammers of other design, other rounding off radii of support rib and rate of movement of pendulum from 4.5 to 7.0 m/sec.

(Amended Edition, amendment No. 2)

2.2. Thermostat, which ensures uniform cooling or heating, absence of aggressive corrosive effect of ambient air on the samples and possibility of controlling of temperatures.

Support and blade pendulum

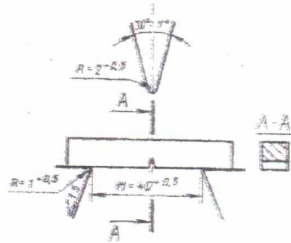


Fig 4

2.3. Mixture of liquid nitrogen (GOST 9293-74) or solid carbon-dioxide («dry ice») with ethyl alcohol. Liquid oxygen and liquid air used as a cooling agent is not permitted.

Mass fraction of oxygen in liquid nitrogen in the process of cooling of samples in thermostat should not be more than 10%.

(Amended edition, amendment No.1, 2)

2.4. Thermometers with an error not more than $\pm 1^\circ\text{C}$ for measuring temperatures of cooling medium.

2.5. Thermometers, including and thermoelectric converters (thermo couples), for measuring temperatures of heating of samples, which ensures measurement with an error, which should not exceed:

$\pm 5^\circ\text{C}$ - with heating temperature up to 600°C .

$\pm 8^\circ\text{C}$ - with heating temperature above 600°C .

2.4, 2.5. (Amended Edition, amendment No. 2)

2.6. Cracks on the samples are obtained on vibrators, manufactured according to normative technical documents.

2.7 Vernier caliper should correspond to the requirements of GOST 166-80. It is permitted to use other measuring devices with measurement error not exceeding those specified in point 1.1.

2.6, 2.7. (Introduced additionally, amendment No. 2)

3. PREPARATION FOR TESTING

3.1. Before starting the test it is necessary to inspect the position of working indicator while free fall of pendulum.

For pendulum hammer with digital calculating device, working indicator in initial position should show «zero» with permissible deviation in the limits of width of dash line according to normative technical documents.

(Amended Edition, amendment No. 1, 2)

3.2. Temperature of samples at the moment of impact is calculated by temperature of testing.

Temperatures of testing are indicated in normative technical documents

on exact product, certified in established order.

3.3. Room temperature is calculated as temperature 20 ± 10 °C.

3.4. For ensuring required temperature of testing, samples before installation on hammer, should be recooled (while the temperature of testing below room temperature) or reheated (while the temperature of testing above room temperature). Degree of recooling or reheating should ensure the required temperature of testing and should be determined by experimenting.

Temperature of recooling or reheating of samples with conditions, so that they can be tested not later than 3-5 sec. after extraction from thermostat, indicated in reference annexure 2.

Holding of samples in thermostat at given temperature (based on the required recooling or reheating) should be not less than 15 min.

(Amended Edition, amendment No. 1)

3.5. The contact with sample part of device for extracting it from thermostat should not change the temperature of samples while installing it on the support of hammer.

4. Conducting of test

4.1. Samples should freely lie on the support of hammer (see fig 4). Installation of samples should be carried out with the help of templates, which ensures symmetrical location of concentrator in relation to the support with the error not more than ± 0.5 mm. While using, end faces of limiter should not be mixed with the samples, which are deformed freely.

4.2. Testing should be carried out during impact of pendulum, with sides, opposite to the concentrator, in plane of its symmetry.

4.3. Impact operation is determined along the scale of pendulum hammer or analogical calculating device.

(Amended Edition, amendment No. 2)

5. Processing of results

5.1. For the result of testing, impact operation or impact strength are used for samples with concentrator of type U and V and impact strength for samples with concentrator of type T.

(Amended Edition, amendment No. 2)

5.2. Impact operation is denoted by two alphabets (KU, KV or KT) and digits. First alphabet (K)- symbol of impact operation,

second alphabet (U, V or T) – type of concentrator. Following digit denotes the maximum energy of impact of pendulum, depth of concentrator and width of sample. Digits are not indicated while determining the impact operation on hammer with maximum energy of impact on pendulum 300 (30.0) Joules ($\text{kgf}\cdot\text{m}$), with depth of concentrator 2 mm for concentrator of types U and V and 3 mm for concentrator of type T and width of samples 10 mm (samples of types 1.11 and 15).

It is permitted to indicate impact operation with two indices (A_i); first (A) – symbol of impact operation; second (i) – symbol of type of samples in conformity with table.

(Amendment edition, amendment No.)

5.3 Impact strength denotes with the combination of letter, and digits.

First two letters KC denotes symbol of impact strength, third letter- type of concentrator; first digit – maximum energy of impact of pendulum, second – depth of concentrator and third – width of sample. Codes are not indicated in case if discussed in point 5.2.

It is permitted to indicate impact strength; second (i) – symbol of the type of samples in correspondence with table.

For code of impact operation and impact strength during decrease and increase in temperatures digital index is taken, which indicates the temperature of testing. Digital index is placed above after alphabet index.

Example:

$KV^{-40} 50/2/2$ – impact operation, determined on the samples with concentrator of type V at temperature minus 40 °C. Maximum energy of impact of pendulum 50 joules, depth of concentrator 2 mm, width of samples 2 mm.

$KCT^{+100} 150/3/7.5$ - impact strength, determined on the samples with concentrator of type T at temperature plus 100 °C. Maximum energy of impact of pendulum 150 joules, depth of concentrator 3 mm, width of samples 7.5 mm.

KCU (KCV) - impact strength, determined on the samples with concentrator of type U (V) at room temperature. Maximum energy of impact of pendulum 300 joules, depth of concentrator 2 mm, width of samples 10 mm.

a_{11}^{-60} - impact strength, determined on the samples with concentrator of type 11 at room at temperature minus 60 °C. Maximum energy of impact of pendulum 300 joules.

(Amended edition, amendment No. 1)

5.4 Impact strength (KC) in $\text{joules}/\text{cm}^2$ ($\text{kgf}\cdot\text{m}/\text{cm}^2$) are calculated according to formula

$$KC = \frac{K}{S_0}$$

Where K – work of impact, joules ($\text{kgf}\cdot\text{m}$);

S_0 – initial cross sectional area of sample at the place of concentrator, cm^2 , is calculated according to formula

$$S_0 = H'_1 \cdot B,$$

Where H'_1 – initial height of the working part of sample, cm;

B – initial width of sample, cm.

H'_1 and B are measured with an error not more than ± 0.05 mm (± 0.005 cm). S_0 is rounded off: with the width of sample 5 mm and less – up to third value of digits, with width of sample more than 5 mm – up to second value of digit

For samples with concentrator of type T the value of H'_1 is determined as the difference between full height H , measured before testing with an error not more than ± 0.05 mm (± 0.005 cm) and estimated depth of concentrator h_p , measured with the help of any optical device having magnification 7 on the surface of fracture of sample after its testing according to sketch, given on fig. 5, with an error not more than ± 0.05 mm (± 0.005 cm).

(Amended edition, amendment No. 1, 2)

5.5 Values KC are recorded in protocol with rounding off: upto 1 (0.1) joules/ cm^2 ($\text{kgf}\cdot\text{m}/\text{cm}^2$) – with the value of KC more than 10 (1) joules/ cm^2 ($\text{kgf}\cdot\text{m}/\text{cm}^2$); upto 0.1 (0.01) joules/ cm^2 ($\text{kgf}\cdot\text{m}/\text{cm}^2$) – with the value of KC less than 10 (1) joules/ cm^2 ($\text{kgf}\cdot\text{m}/\text{cm}^2$).

(Amended edition, amendment No. 1)

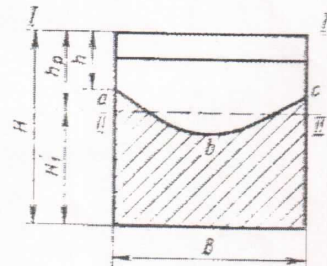
5.6. If, as a result of testing, sample is not destroyed completely, then the indicator of the quality of material is considered unestablished. In this case, it is indicated in the protocol of testing, that samples with maximum energy of impact on pendulum, was not destroyed.

Results of testing are not considered in case of fracture of samples for defects of metallurgical production.

(Amended edition, amendment No. 2)

5.7. In case of change of samples, the reason is indicated in protocol of testing.

5.8. Initial data and results of testing of samples are recorded in testing protocol. Format of protocol is given in recommended annexure 3.



abc – Front of fatigue cracks; I-I – Position of sighting line of eye piece of microscope in the initial moment of measurement (coincides with the face of sample) II-II – Position of sighting line of eye piece of microscope at end of measurement (position II-II – is selected so that the shaded area higher than line would be isometric with the non-shaded area below the cross line)

Fig. 5

APPENDIX 1
Reference

Area of usage of samples

Type of concentrator	Type of sample	Application area
U	1-10	During selection of sample, acceptance test of metals and alloys
V	11-14	During selection, acceptance tests of metals and alloys for the structures of the higher degree of reliability (flying vehicles, transport means, pipelines, pressure devices etc.)
T	15-20	During the selection of samples and the acceptance inspection of metals and alloys for specially critical designs, for which evaluation of the resistance to development of crack is of paramount importance. During the investigation of the reasons for destruction of the critical structures.

(Amended edition, amendment no. 1)

APPENDIX 2
Reference

Temperature of cooling and heating depending on the testing temperature

Testing temperature, °C	Temperature, °C	
	Cooling	Heating
Above minus 100 upto minus 60	4-6	-
Above minus 60 upto minus 40	3-4	-
Above minus 40 upto plus 10	2-3	-
Above plus 30 upto plus 200	-	3-5
Above plus 200 upto plus 400	-	5-10
Above plus 400 upto plus 500	-	10-15
Above plus 500 upto plus 600	-	15-20
Above plus 600 upto plus 700	-	20-25
Above plus 700 upto plus 800	-	25-30
Above plus 800 upto plus 900	-	30-40
Above plus 900 upto plus 1000	-	40-50

PROTOCOL FOR TESTING ON IMPACT BENDING

Grade of Impact testing machine _____

Maximum energy of impact of pendulum while testing _____

Speed of pendulum at the moment of impact _____ m/c

Testing material _____

Number	Markings of samples	Melt number	Batch number	Type of samples	Testing temperature, °C	Width of samples B	Height of samples H	Depth of concentrator h	Height of working section H ₁	Cross sectional area S ₀ , cm ²	Work of impact K, joules (kgf•m)	Impact strength KC, Joules/cm ² (kgf•m/cm ²)	Remark
						cm							

(Amended edition, amendment No. 1)

REFERENCE NORMATIVE TECHNICAL DOCUMENTS

Code НТД, on which reference is given	Point number, section
GOST 577-68	1.5
GOST 7564-73	1.2
GOST 9293-74	2.3
GOST 10708-82	2.1

Reprinted [June 1990] with Amendment No. 1, 2, certified in October 1981, March 1988, [ИУС 12-81, 6-88]